Spontaneous Wound Dehiscence after Removal of Single Continuous Penetrating Keratoplasty Suture

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Purpose: To determine the incidence and complications of spontaneous wound dehiscence after removal of a single continuous penetrating keratoplasty (PK) suture.

Design: Retrospective consecutive, noncomparative interventional case series.

Methods: Retrospective review of 324 consecutive continuous suture PKs performed between 1992 and 1999.

Results: Sixty-nine (21.3%) of 324 PKs reviewed had the continuous suture removed. The average interval for suture removal after PK was 24.5 ± 15 months (range, 2.8–63.3 months). Five of the 69 eyes (7.2%) developed spontaneous wound dehiscence without direct eye trauma. In the five eyes that developed wound dehiscence, the continuous suture was removed at 24.6 ± 10.3 months (range, 14–42 months). Dehiscence occurred at 11.6 ± 6.5 (range, 3–18) days after suture removal. Significant history associated with wound dehiscence included coughing, yawning, falling without trauma to the eye, and spontaneous wound separation. The reasons for suture removal were astigmatism in four of five (80%) patients and a broken suture in one of the five patients. In four of five (80%) patients, the location of wound dehiscence correlated with the steep axis of corneal keratometry before suture removal. Surgical intervention preserved the presuture removal best-corrected visual acuity in four of the five eyes. No eyes with an intact suture spontaneously dehisced.

Conclusions: The rate of spontaneous wound dehiscence after removal of a continuous suture in our series was 7.2%. All spontaneous dehiscences occurred within 2 weeks after suture removal. Older patients, who had PK for corneal edema with postoperative astigmatism and have been using corticosteroids drops for prolonged periods of time, are at higher risk of wound dehiscence. Patients should be monitored closely during the first 2 weeks after removal of a continuous suture for signs of wound separation, especially when suture removal is performed for astigmatism. Patients should be cautioned about the risk and symptoms of wound dehiscence before suture removal to facilitate early recognition and intervention for preservation of best visual potential.
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Wound dehiscence after penetrating keratoplasty (PK) can delay visual rehabilitation and increase the risk of endophthalmitis, corneal edema, corneal allograft rejection, and choroidal hemorrhage.[1–3] Dehiscence or rupture of the wound after corneal grafting may occur spontaneously[1–6] or after direct trauma to the eye.[7–16]

Spontaneous wound dehiscence may occur after PK using continuous, interrupted, or combined suture technique.[3] Dehiscence may occur in the early postoperative period,[1–6] the late postoperative period before suture removal,[1–6] or after suture removal.[1–6] Previous reports have identified many factors associated with corneal wound dehiscence after PK, including age, increased intraocular pressure, obesity, postoperative steroid use, time of suture removal, preoperative corneal edema, and corneal wound healing.[1–6] Nylon sutures are used preferentially by most cornea surgeons for keratoplasty because of the tissue compatibility of nylon. However, nylon sutures can also be associated with poorer corneal healing because of the lack of tissue irritation compared with silk sutures.[2] Intraoperative challenges caused by irregularities in wound morphology caused by a thin or necrotic recipient bed have been associated with immediate postoperative wound separation.[3] In this study we report the incidence and complications of spontaneous wound dehiscence after removal of a single continuous PK suture.

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Patients and Methods

The medical records of all patients who underwent a PK by a single corneal surgeon (WSVM) from June 1992 through February 1999 were retrospectively reviewed. Patients who had wound closure with anything other than a single continuous suture were excluded from the study. Preoperative, intraoperative, and postoperative data were collected on patients who had a single continuous

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Table 1. Reasons for Suture Removal in 69 Eyes of the 324 Cases of Keratoplasty with Continuous Suture

Cause of Suture Removal	No. of Cases	% of Cases
Astigmatism	25	36.2
Loose suture	13	18.8
Broken suture	13	18.9
Not documented	11	15.9
Filamentary keratitis	2	2.9
Neovascularization	2	2.9
Anisometropia	1	1.4
Herpes simplex virus ulcer	1	1.4
Scarring	1	1.4

suture removed. Eyes that had repeat PK and that met the previous criteria were included.

Preoperative data collection included patient age, gender, involved eye, preexisting ocular disease, and preoperative best-corrected Snellen visual acuity (BCVA). Intraoperative data collection included procedures performed (PK alone or in combination with other procedures) and any complications that may have occurred. Postoperative data collection included BCVA, corneal keratometry, presence of suture, date and cause of suture removal, keratometry after suture removal, any complications after suture removal, and location of wound dehiscence if present. Patients who were lost to follow-up or died within 6 months after PK were assumed to have their sutures intact and were excluded from the study.

Results

From June 1992 through February 1999, we identified 324 consecutive PKs using a single 10-0 nylon continuous suture performed by one surgeon (WSVM). Sixty-nine eyes had the continuous suture removed, whereas the remainder of the patients had their suture intact. The general preference was to keep the suture in place unless there was a reason to take it out. The average time of suture removal was 24.5 ± 15 months (range, 2.8–63.3 months) postoperatively. All patients with unacceptable astigmatism had their sutures adjusted postoperatively. Reasons for suture removal are listed in Table 1.

Five of the 69 eyes (7.2%) developed wound dehiscence without direct eye trauma after suture removal. Sutures in these five patients had been removed at 24.6 ± 10.3 months (range, 14–42 months) after PK. Dehiscence occurred at 11.6 ± 6.5 days (range, 3–18 days) after suture removal (Table 2).

Reasons for suture removal in patients who developed wound dehiscence were astigmatism (four patients) and broken suture (one patient) (Table 2). Events associated with wound dehiscence included coughing, yawning, falling without head trauma or trauma to the eye, and spontaneous (Table 2). Indications for keratoplasty in patients who developed wound dehiscence after suture removal were pseudophakic bullous keratopathy (two patients), keratoconus (two patients), and Fuchs' dystrophy (one patient).

One patient (No. 4) had a repeat PK because of previous graft failure and opacification; no corneal edema was noted in the recipient corneal bed during regrafting. One patient (No. 2) required an enucleation after wound dehiscence caused by severe coughing that led to extrusion of intraocular content. One patient (No. 5) developed visually significant cataract and underwent uncomplicated phacoemulsification with intraocular lens implantation 8 months after wound dehiscence repair. Presuture removal BCVA and keratometry, postwound dehiscence repair BCVA, and post-PK follow-up duration are summarized in Table 3.

Discussion

With more than 46,000 corneas grafted last year, PK is the most frequently performed homologous transplant procedure in the United States.[17] The timing of suture removal after PK varies from surgeon to surgeon, and little substantive evidence exists for the optimum time for suture removal. Factors affecting the length of time sutures are kept in include age, number and type of sutures, BCVA, and wound healing. Signs of adequate wound healing include contraction of wound with loosening of sutures, ingrowth of deep stromal vessels, and the appearance of a white translucent scar in the wound.

Wound Healing

Gasset and Dohlman[18] demonstrated that the tensile strength after full-thickness corneal incision in rabbits was preceded by a lag period of approximately 6 days, during which no detectable tensile strength was found in the wound. After the lag period, there was a steep climb to approximately 30% of the normal tensile strength at the 25th postoperative day. By the 100th postoperative day, the tensile strength was approximately 50% that of normal intact corneal tissue. Wounds in the peripheral cornea healed significantly faster than did those in the center.

Table 2. Patient Data

Patient Number	Age	Gender	Diagnosis	Time of Suture Removal after Keratoplasty	Cause of Suture Removal	Dehiscence After Suture Removal	Cause of Wound Dehiscence
1B	67	F	PBK	42 mos	Broken suture	9 days	Spontaneous
2A	80	F	PBK	22 mos	High astimatism	3 days	Coughing
3W	65	F	Fuchs	14 mos	Irregular astigmatism	11 days	Fall (no eye trauma)
4G	74	M	Keratoconus	23 mos	Irregular astigmatism	18 days	Spontaneous
5H	56	F	Keratoconus	22 mos	High astigmatism	18 days	Yawning

PBK = pseudophakic bullous keratopathy.

Table 3. Presuture Removal Best-corrected Visual Acuity and Keratometry, after Wound Dehiscence Repair Best-corrected Visual Acuity, and after Penetrating Keratoplasty Follow-up Duration

Patient No.	Suture-In Best-corrected Visual Acuity	Suture-In MRX	Suture-In Ks	Postdehiscence Repair Best-corrected Visual Acuity	Postdehiscence Follow-up
1B	20/60	−12.00 + 6.00 × 120°	44.75/48.00 × 090°	20/50	23 mos
2A	20/100	−6.50 + 5.00 × 102°	39.00/45.50 × 114°	Enucleation	N/A
3W	20/70	+0.50 + 1.50 × 046°	N/A	20/20	42 mos
4G	20/40	plano + 3.50 × 102°	39.00/42.50 × 090°	20/40	41 mos
5H	20/60	−1.00 + 6.00 × 140°	40.75/44.00 × 180°	20/25*	8.5 mos

*Patient underwent cataract surgery 8 months after repair of wound dehiscence.

KS = Suture-In keratometry; MRX = Suture-in refraction; NA = not available.

Calkins et al[19] demonstrated that the graft host interface is not of normal strength even 1 year after PK and even if the wound seems fully healed. Others have made similar observations on corneal wound strength after radial keratotomy.[20–23]

Causes of Wound Dehiscence

PK wound dehiscence may occur spontaneously[1–6] or after direct trauma to the eye.[7–16] Spontaneous wound dehiscence after PK has been reported in the early postoperative period, before suture removal, and after suture removal.[3] Early postoperative spontaneous PK wound dehiscences are generally related to intraoperative difficulties.[3] Wound dehiscence that occurs later after PK and before suture removal has been related to severe glaucoma with increased intraocular pressures greater than 40 mmHg.[3] Spontaneous wound dehiscence after suture removal is usually related to inadequate wound healing and has been noted to occur shortly after suture removal.[2,3] Wound dehiscence has been related to age, preoperative corneal edema, use of nylon suture (not inducing inflammation), and the use of postoperative steroids.[2,3]

Dehiscence Related to Suture Technique

Binder et al[3] reported a 5.7% (21 of 369 PK) incidence of spontaneous wound dehiscence after PK using all suture techniques (continuous, interrupted, or combined). This 5.7% incidence included wound dehiscences that occurred with sutures in as well as sutures out. Binder et al showed that wound dehiscence was not related to specific suture technique using nylon sutures (interrupted 10-0 nylon, continuous 10-0 nylon, or combined continuous 15-0 nylon with eight interrupted 10-0 nylon sutures). Of 40 wound dehiscences noted (4 patients before 1971, 21 patients in his series, and 15 patients after 1973), 21 patients dehisced within 2 days of suture removal. Brown and Tragakis[2] reported a rate of wound dehiscence of 28.6% (8 of 28) in patients with a single continuous suture that was removed 3 to 8 months after PK. All eight wounds dehisced almost immediately after suture removal. In our study, a continuous 10-0 nylon suture was used for all 324 PKs. Sixty-nine eyes had their continuous suture removed at 24.5 ± 15 months (range, 2.8–63.3 months). The incidence of spontaneous dehiscence of the wound after suture removal was 7.2% (5 of 69 PKs) and wound dehiscence occurred at 11.6 ± 6.5 days (range, 3–18 days) after suture removal.

Visual Acuity Outcome

The data of Binder et al[3] suggest that patients with better vision were more likely to lose BCVA than patients with poor vision. Thirty-seven patients had a BCVA of 20/200 or worse before wound separation, and 30 patients had a BCVA of 20/200 or worse after repair of wound separation. Three of 40 patients had BCVA of 20/100 or better before wound separation and 10 of 40 patients had a BCVA of 20/100 or better after repair of wound separation. Postrepair BCVA included 10 patients with wound separations that were subsequently regrafted. Twelve of 19 patients with complete wound separation had immediate graft failure, and 7 of these required immediate regrafting. In the other 21 grafts with only anterior wound gapes, repair was easier, and grafts were clearer compared with transplants with complete wound separation. Brown and Tragakis[2] did not report visual acuity in their study.

In our report, one patient underwent enucleation because of a suprachoroidal hemorrhage and extrusion of intraocular content immediately after wound dehiscence. None of the patients who developed wound dehiscence required a regraft. With the exception of the patient who lost the eye from suprachoroidal hemorrhage, presuture removal BCVA of 20/70 or better was preserved after repair of the wound dehiscence (Table 2). The BCVA of patient 5 was improved to 20/25, which was probably related to cataract surgery that was performed after wound dehiscence repair. One difference between this study and that of Binder et al is a longer time period before suture removal (14–42 months compared with 4–6 months). This may explain the better final outcomes in our study. In addition, our follow-up time, after wound dehiscence repair, may have been longer (8.5–42 months), and that would allow greater recovery of vision. Binder et al[3] did not mention the length of postdehiscence repair follow-up.

Astigmatism Related to Site of Dehiscence

Astigmatism is an inherent side effect of penetrating keratoplasty that is usually managed with suture adjustment,

Table 4. Indication for Corneal Transplant in the 69 Patients with Sutures Removed

Indication for Penetrating Kerotoplasty	No. of Patients	% of Patients
PBK	20	29.0
Keratoconus	15	21.7
Fuchs' dystrophy	14	20.3
Aphakic corneal edema	5	7.2
Failed corneal graft	4	5.8
Corneal scarring	3	4.3
Amyloid deposit	2	2.9
Lattice dystrophy	1	1.4
Interstitial keratitis with corneal edema	1	1.4
Idiopathic corneal edema	1	1.4
Rheumatoid arthritis perforation	1	1.4
High residual corneal astigmatism	1	1.4
Unavailable data	1	1.4

PBK = pseudophakic bullous keratopathy.

Table 5. Age Distribution of the 69 Patients with Penetrating Keratoplasty with the Single Continuous Suture Removed

Age (yrs)	No. of Patients	% of Patients
21–30	7	10.1
31–40	6	8.7
41–50	8	11.6
51–60	7	10.1
61–70	15	21.7
71–80	14	20.3
81–90	12	17.4

suture removal, or rigid gas-permeable contact lenses. A tight radial suture creates a flatter cornea at the site of the suture in the periphery and a steeper cornea centrally, inducing astigmatism along the meridian of the radial suture similar to a resected wedge of tissue. Releasing the tension of tight sutures should release the tension at the corneal wound and reduce astigmatism along the suture meridian. The release of tension at the time of suture removal can change the wound architecture and tension distribution in the wound, putting more stress on the graft-host junction, resulting in wound gape and dehiscence.

In our study, astigmatism was the main indication for suture removal in 25 of the 69 patients (36.2%). Unacceptable astigmatism was the indication for suture removal in four of the five patients who developed wound dehiscence (two patients with irregular astigmatism and two patients with astigmatism greater than 3 diopters [Table 2]). The fifth patient had his suture removed because it was broken. This patient with a broken suture had 3.25 diopters of astigmatism (44.75/48.00 × 090) before suture breakage (Table 3). The rate of spontaneous wound dehiscence among patients with sutures removed because of astigmatism only was 16% (4 of 25 patients).

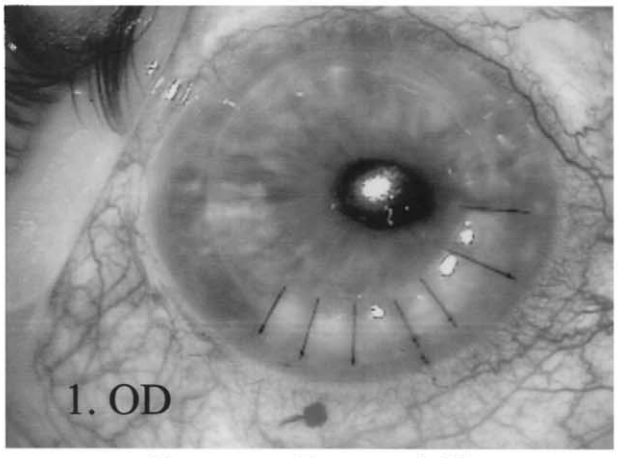
In four (80%) of five patients in our study the location of wound dehiscence correlated with the steep axis of corneal keratometry before suture removal (Fig 1). This correlation of the site of wound dehiscence with the steep axis of astigmatism suggests that astigmatism, known to be a sign of irregular wound apposition caused by trephination and/or donor host alignment at the initial suture placement, is a sign of wound weakness that could be the cause or the result of poor wound healing and predispose to wound dehiscence.

Other Factors Associated with Wound Dehiscence

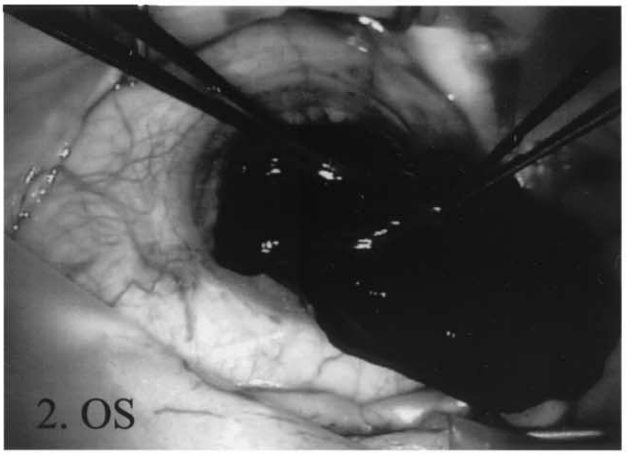
Previous reports have highlighted multiple factors associated with corneal wound dehiscence after PK, including increased age, increased intraocular pressure, obesity, prolonged postoperative steroid use, nylon sutures, time of suture removal, preoperative corneal edema, and corneal wound swelling.[1–6] Three of five patients in our study who developed wound dehiscence were coughing, yawning, or fell before developing wound dehiscence, and all of these activities could cause an increase in intraocular pressure and stress the corneal wound.

Corneal edema is one of the more common indications for keratoplasty. Binder et al[3] reported that 25 of 39 patients with combined continuous and interrupted sutures who developed wound dehiscence had corneal swelling as a preoperative indication for PK. Most interrupted sutures were removed at between 6 and 10 weeks, and most running sutures were removed after 4 months. Brown and Tragakis[2] reported that six of the eight patients who developed wound dehiscence had corneal edema as a preoperative indication for PK. All patients in their series had their continuous sutures removed at from 3 to 8 months after PK. In our study, all patients had a continuous suture only, and no interrupted sutures were used. Of the 69 patients who had removal of the single continuous suture, corneal edema was the main indication for PK in 40 patients (58.0%) (19 patients with pseudophakic bullous keratopathy, 14 patients with Fuchs' dystrophy, 5 patients with aphakic corneal edema, 1 patient with interstitial keratitis and corneal edema, and 1 patient with idiopathic corneal edema) (Table 4). Three of five patients (60.0%) who developed wound dehiscence in our study had corneal edema as the main indication for PK (two pseudophakic bullous keratopathy and one Fuchs' dystrophy). Continuous sutures in these three patients were removed at 14, 22, and 42 months after PK. The other two patients had keratoconus as their preoperative diagnosis. The comparable prevalence of preoperative corneal edema in all 69 patients, as well as in the five patients who developed wound dehiscence, does not suggest that preoperative corneal edema is a predisposing factor for wound dehiscence in our study.

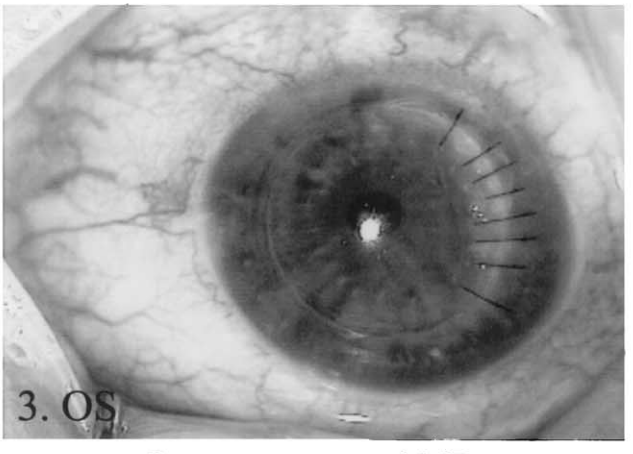
Topical corticosteroid drops are used by most corneal surgeons after PKs to prevent and control donor tissue rejection, and these drops are known to slow down healing of corneal tissue. Brown and Tragachis[2] reported that all patients were weaned to only one corticosteroid drop a day for at least 6 weeks before suture removal. Binder et al reported that all patients in their report who developed wound dehiscence received postoperative corticosteroid drops that could have interfered with wound healing. In our study it was the preference of the main surgeon (WSVM) to keep all patients on at least one steroid drop a day throughout the period of follow-up, even 42 month after PK.



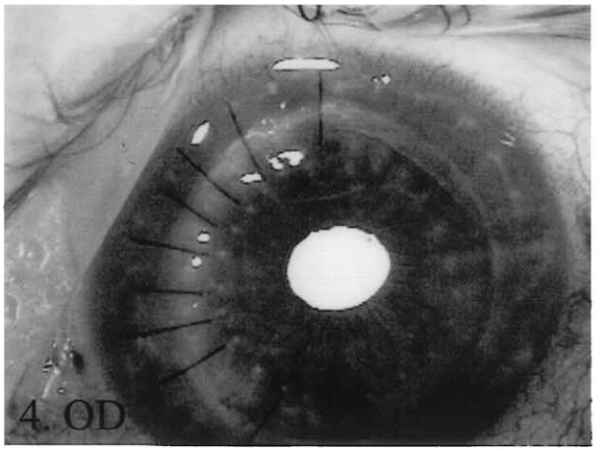
Presuture Removal Ks:
44.75/48.00x090



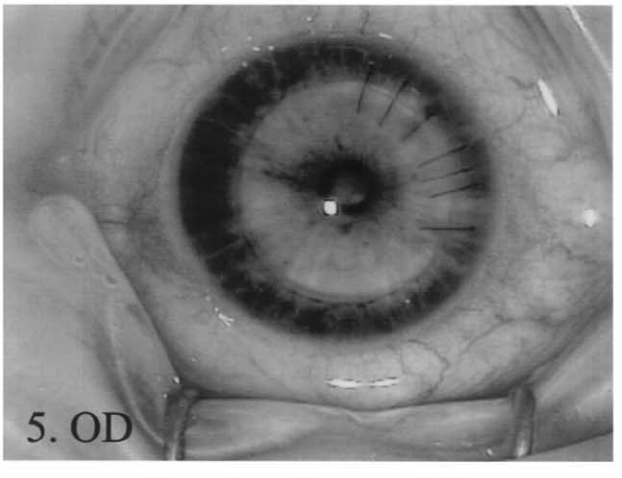
Presuture Removal Ks:
39.00/45.50x114



Presuture removal MRx:
+0.50+1.50x046



Presuture Removal Ks:
39.00/42.50x090



Presuture Removal Ks:
40.75/44.00x180

Figure 1. Photograph of corneal wound dehiscence during (2) and after (1, 3–5) repair show the correlation between keratometry and wound dehiscence location. Keratometry readings before wound dehiscence are shown under each corneal photo. Refraction is provided for number 3, because no keratometry was documented. Ks = Suture-In Keratometry; MRX = Suture-In Refraction.

The extended use of corticosteroid drops could have been a major contributing factor in the high rate of wound dehiscence in our study.

The age of patients plays an important role in corneal tissue healing, with younger patients healing much faster than older patients, mandating earlier suture removal after PK. In our study, 48 of 69 (69.6%) patients were 50 years or older (Table 5), and all patients who developed wound dehiscence were 50 years or older (Table 2). None of the patients with ages less than 50 years developed wound dehiscence.

Conclusion

The rate of spontaneous wound dehiscence after removal of a single continuous suture in our 69 patients was 7.2% (5 patients) and 16% (4 of 25 patients) in patients who had their sutures removed due to visually unacceptable astigmatism. Wound dehiscences occurred along the steeper meridian of astigmatic corneas in four of five patients. One dehiscence was as far out as 42 months after PK. This illustrates that time alone is not a sufficient criterion for the safety of suture removal. All spontaneous dehiscences occurred within 2 weeks after continuous suture removal. Adequate early intervention preserved BCVA in four of five cases.

Single continuous suture removal should not be viewed as risk free even 2 years or more postoperatively. When making the decision to remove a single continuous suture, the surgeon should carefully examine the wound for stability. Older patients, who had PK for corneal edema with postoperative astigmatism and have been using corticosteroid drops for prolonged periods of time, are at higher risk of wound dehiscence. Patients should be informed about the risks of wound dehiscence and educated about the early symptoms such as acute deterioration in vision, excessive tearing, or pain. Patients are to report such symptoms immediately to their ophthalmologist. Close monitoring of patients after suture removal for signs or symptoms of wound separation, particularly during the first 2 weeks, should be undertaken to facilitate early recognition and intervention if necessary for preservation of vision.

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